AP Biology
The Process of Meiosis - Part 2
(Associated Learning Objectives: 1.5, 1.14,1.15, 1.16, 2.22, 2.31, 2.32, 3.1, 3.3, 3.8, 3.9, 3.10, 3.11, 3.12, 4.1)

Important concepts from previous units:
Evolution is "change over time".
Sexual reproduction involves *haploid* sperm and egg gametes.
The DNA within the egg and sperm *will create* the *next* generation organism.

Meiosis - means "The process of *gamete* formation"
This process occurs in the cells of the *sex* organs of the organism. These organs are called **Gonads.**
This process has *2 divisions* in the process *after* the S and G2 phases.
Remember , that the S phase *doubles the number of chromosomes*. In humans 46 → 92.
Meiosis I - This division is the separation of chromosome *pairs***.** In humans, 92 → 46
Meiosis II - This division is the separation of *sister chromatids***.** In humans, 46 → 23
In this process, males produce **4** haploid sperm; each having 23 chromosomes.
In this process, females produce **1** haploid egg with 23 chromosomes. The other three cells *degrade* into structures called **polar bodies** during the process. These can be seen on the *nucleus membrane* in female cells, not males.
Stages to the process of Meiosis
These stages are *very similar* to the stages of Mitosis.
Three major differences, from Mitosis, are present to *increase variation.*
(Remember, Mitosis is *normal* cell division. It basically makes *clones* of the adult. *No variation*.)
Crossover ("genetic swapping") occurs in **Prophase I**. (Creates variation.)
Chromosome *pairs* separate in **Anaphase I**. (Creates Variation.)
Sister Chromatids separate in **Anaphase II.** (Creates Variation.)

Crossover ("genetic swapping") between *homologous* chromosomes.
This creates *variation from the parent's genome*. They are then called **Recombinant Chromosomes**.
Synapsis – Chromosomes that are in a state of being *intertwined together*. ("syn" means "together"; "sis" means "process of")
Tetrad - *Four* chromosomes *twisted together* ("tetra" means "four"… Like the game Tetris has four different shapes.)
Chiasmata – Where the chromosomes physically *overlap* making an "x". (Chi is the Greek letter for X.)

Major *differences* between Mitosis and Meiosis:
The *number of divisions* (Mitosis has 1; Meiosis has 2)
The *final products* of each process (Mitosis – "cloned" daughter cells; Meiosis – haploid gametes)
Crossover, in Prophase I, creates variation (No crossover in Mitosis)
Chromosome pairs vs. sister chromatids separating in the *second division* to *reduce* DNA to haploid state.

Sources of variation creation
Independent assortment of chromosomes. (This happens 2x in Anaphase I and II.)
1. 2 = Total number of possibilities (One goes one way; the other the other way in separation.)

n = number of variables; 23 = number needed to make a haploid set in humans.
$2^n = 2^{23}$
For humans the total is about *8 Million possibilities* for *each* parent *with each* division.
8Million possible outcomes X 2divisions X 2 parents = 4,096,000,000 *possible combinations* for just 46 chromosomes!
Now add in **Crossover** ("genetic swapping")
Amount of crossing over varies from tetrad to tetrad. If *little* crossover occurs, the offspring looks *very much like* the adult parent. If *lots* of crossover occurs, the offspring looks *very different* from the adult parent.
Random fertilization by a sperm. (There are millions released by the male. Which one will make it to the finish line?)
That makes *you* a 1 in 70 *trillion possibility* – YOU ARE PRETTY DARN SPECIAL!

Evolution? As organisms became *more complex*, a more complex and more *survival oriented* way of reproducing came into existence over *millions of years*. The addition of a *second division* with a couple of slight changes in the *same* four steps (Prophase, Metaphase, Anaphase, and Telophase) creates the variation. The variation helps with survival and this would be beneficial in *changing environments*. Those that survive long enough get to *reproduce* and keep the species going. Those that don't do not pass on those *defective* traits for surviving in that environment.